JAPANESE PATENT OFFICE
PATENT JOURNAL (A)
KOKAI PATENT APPLICATION NO. SHO 62[1987]-67936

Int. Cl.[4]:	H 04 B 1/38 1/08 H 05 K 5/02 7/20
Sequence Nos. for Office Use:	7251-5K Z-6745-5K Z-6921-5F 7373-5F
Filing No.:	Sho 60[1985]-207551
Filing Date:	September 19, 1985
Publication Date:	March 27, 1987
No. of Inventions:	1 (Total of 6 pages)
Examination Request:	Filed

RADIO COMMUNICATION DEVICE

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[There are no amendments to this patent.]

Claims

1. A type of radio communication device characterized by the fact that it has a box-shaped main body that accommodates the main part of the radio communication device, a quick-connecting/disconnecting lid that covers and seals the opening of the aforementioned main body, and an RF amplifier section that is mounted to be in contact with the outer surface of the bottom portion of the aforementioned main body in a quick-connecting/disconnecting manner.

2. The radio communication device described in Claim 1 characterized by the fact that it has heat dissipating fins on the side outer surface of the aforementioned main body.

3. The radio communication device described in Claim 1 characterized by the fact that for the aforementioned RF amplifier section, an RF amplifier section with a high rate of heat generation is assembled to be in close contact with the inside surface, and heat dissipating fins are arranged on the outside surface.

4. The radio communication device described in Claim 1 characterized by the fact that each of the contact regions of the aforementioned main body with the lid as well as with the RF amplifier section is surrounded by a packing member for airtightness and electromagnetic shielding.

Detailed explanation of the invention

Outline

This invention pertains to a structure of a radio communication device in which the main part of the circuitry of the radio communication device is accommodated in a box-shaped main body, and highly efficient cooling is achieved with the RF amplifier section that requires cooling being cooled as a separate member.

Industrial application field

This invention pertains to a type of miniaturized radio communication device. In particular, this invention pertains to an assembly structure for a miniaturized radio communication device.

In the recent years, radio devices that make use of ultrahigh-frequency waves, including microwaves and millimeter waves, have been developed in solid-state form up to the RF region. High-density assembly progresses along with efforts to miniaturize such devices, and a topic to be addressed becomes how to effectively dissipate the heat generated by the device.

When an electric fan or cooler is used to dissipate heat in a forced way, an excessive amount of electric power is needed, and this is undesirable. Consequently, there is a need to develop a method of natural heat dissipation that can dissipate heat uniformly.

Prior art

When radio communication with a remote site is performed via a communication satellite, a high communication output power is needed. Figure 7 is a schematic oblique view illustrating a conventional radio communication device for this purpose. In this radio communication device, the main part is accommodated in receiver (12) and transmitter (13) mounted on frame (11), and transmitter (13) is connected to adjacent RF amplifier section (14) via RF cable (15).

The RF output signal of RF amplifier section (14) is transmitted via waveguide (16) to polarization branching filter (17). It is then transmitted from said polarization branching filter (17) to an antenna not shown in the figure via waveguide (18). On the other hand, the RF input signal received from the aforementioned antenna is transmitted via waveguide (18) to polarization branching filter (17). It is then input to receiver (12) via another waveguide (19) connected to the polarization branching filter.

The RF output is in the 14-GHz band, and its [free] space propagation state is as a vertically polarized wave. On the other hand, the RF input is in the 12-GHz band, and its space propagation state is as a horizontally polarized wave. Consequently, waveguide (18) has a square or circular cross section that allows transmission in these two states, with polarization branching filter (17) being used to separate these two output and input signals.

The many signal leads, control leads, and power source leads connected to the aforementioned devices are not shown in the figure. These devices are independent from each other and have separate covers applied to them, to form a cubic shape as that shown in the figure. However, because it is inappropriate to expose them outdoors, they are placed indoors, or accommodated in an appropriate enclosure that shields them from wind and rain.

Heat generated in the received signal processing circuit inside receiver (12) and the transmitted signal processing circuit inside transmitter (13) should be well dissipated up to the final output stage in order to ensure high reliability of operation.

A traveling wave tube (TWT) is used as the RF amplifier section (14) that amplifies the RF signal from transmitter (13) and outputs the signal. Because a large amount of power is needed to operate a TWT, heat is generated and cooling is needed to maintain operation. For this purpose, a large heat dissipating unit (14a) is exposed on the vertical surface of the device, and because it makes contact with the interior, natural air cooling is performed.

Problems to be solved by the invention

For the aforementioned conventional radio communication device, receiver, transmitter, and RF amplifier section are independent from each other, and they are integrated together by means of a frame. The overall device is bulky and cannot be directly exposed to the outdoors.

Consequently, handling and service are inconvenient. With the antenna included, the system becomes even more bulky and complicated. This is a problem.

Means to solve the problems

The purpose of this invention is to solve the aforementioned problems of the conventional methods by providing a type of radio communication device. As illustrated in Figure 1, a cross section, and Figure 2, an oblique view, the radio communication device has the following parts: box-shaped main body (22) that accommodates main part (21) of the radio communication device, lid (24) that covers and seals opening (23) of main body (22) in a quick-connecting/disconnecting manner, and RF amplifier section (27) mounted on outer surface (26) of bottom portion (25) of main body (22) in a quick-connecting/disconnecting manner.

Also, there are heat dissipating fins (28) attached on the outer side surface of main body (22). RF amplifier (29) with a high heat generating rate is assembled in close contact with the inclined side surface of RF amplifier section (27), and heat dissipating fins (30) are arranged on the outer surface side of the RF amplifier section. In addition, at least the main body (22) contact regions with lid (24) as well as with RF amplifier section (27) are surrounded by a packing member for airtightness.

Operation

Inside the main body, the transmitter and receiver are arranged neatly on the left and right sides, respectively, on the bottom. This configuration facilitates assembly and service. Heat generated by these parts passes to the side surface through the bottom portion, and is dissipated naturally to the surrounding space through the heat dissipating fins on the outer side surface. Although the RF amplifier section is attached as a separate member on the outer surface of the bottom portion, because natural heat dissipation to the surrounding space can be achieved through the heat dissipating fins on its outer surface, the overall size is very small, and it has excellent watertightness properties, so that it can also be mounted directly on the antenna.

Application examples

In the following, the radio communication device of this invention will be explained in detail with reference to application examples illustrated by figures.

Figures 3-6 illustrate an application example of this invention. Figure 3 is an oblique view illustrating the state with the lid opened. Figure 4 is a cross section illustrating the main features. As shown in the figures, the system is composed of the following parts: box-shaped main body (33) that accommodates receiver (31) and main part (32) of the transmitter of the

radio communication circuit, quick-connecting/disconnecting lid (35) that covers and seals opening (34) of main body (33), and RF amplifier section (38) mounted, in a quick-connecting/ disconnecting manner, in contact with outer surface (37) of bottom (36) of main body (33).

Compartment (39) of main body (33) has a flange around the periphery of upper opening (34). Two grooves are formed in its upper surface. Electromagnetic shielding member (41) is inserted in inner groove (40), and airtight (waterproof) protective ring (43) is inserted in outer groove (42) to surround the upper surface (Figure 4a). The flange surface of lid (35) with the same shape is flat, with holes (44) formed in its outer part for fastening bolts.

Plural heat dissipating fins (45) are formed on the outer side surface of compartment (39). Also, outer surface (37) of bottom portion (36) is a flat surface.

Recess (46) is formed in the inside surface of the enclosure of RF amplifier section (38). RF amplifier unit (48) is mounted by means of screws (49) to make close contact with inner surface (47) of said recess. This unit (48), which is not shown in detail, comprises a solid-state amplifier that has an RF input terminal on one side, and an amplified high-output terminal on the other side.

Also, plural heat dissipating fins (50) are formed laterally on the outer surface of the bottom portion of RF amplifier section (38). Surface (51) that is in contact with bottom outer surface (37) of main body (33) has the same shape as that of surface (37). It has two grooves formed on its periphery. Electromagnetic shielding member (53) is inserted in inner groove (52), and airtight (waterproof) protective ring (55) is inserted in outer groove (54) to surround the surface. Holes (56) are formed in the outer part, for fastening bolts (Figure 4b).

It is preferred for said compartment (39) of the main body, lid (35), and enclosure (57) of the amplifier section be made of a compact aluminum alloy casting, which has a high thermal conductivity, high strength and high corrosion resistance, as an integrated body which is then subjected to high-precision processing, surface coating, etc.

As shown in Figure 3, heat dissipating fins (45) of compartment (39) of the main body, and heat dissipating fins (50) of enclosure (57) of the RF amplifier section are oriented vertically in horizontal rows. This direction is preferred for cooling by means of the natural convection of air that flows over the surface. As in Figures 1 and 2, by arranging the fins in the horizontal direction, air can still flow well even when the device is arranged tilted from front to back.

In Figure 3, A refers to the antenna side, and B refers to the side for feeding in the cables (neither is shown in the figure). On side A, waveguide (58) with a circular cross section allows transmission of both polarized waves, and is connected to the antenna. Waveguide (58) is positioned in agreement at the center of the circle represented by double-dot/dash line C in Figure 4, which includes compartment (39) of the main body and the maximum extent of the profiles of lid (35) and RF amplifier section (38). Side B has a cable feed-in port having a

circular outer shape (not shown in the figure) at the same position. As a result, the overall device can be supported rotatably by these parts, and it is easy to arrange the polarization directions of the transmitted and received waves with a difference of 90° between them at will. The same is true for the case shown in Figures 1 and 2.

Figures 5 and 6 illustrate the configuration of the connection between RF amplifier unit (48) and the output waveguide on the antenna side. Figure 5 is an oblique view, and Figure 6 is a cross section. Base plate (59) of unit (48) made of a metal is connected to recess (46) of enclosure (57) of the amplifier section. Circuit substrate (60) is carried on the upper surface of the base plate, with output terminal (61) of a flat circuit (stripline) formed on it.

Through-hole (62) is formed on the side surface of unit (48) to correspond to output terminal (61), and conversion waveguide (63) is attached from the outside with screws by means of mounting plate (63'). Mounting plate (63') is arranged on one side surface of conversion waveguide (63), and a hole is formed in it. Tube (64) made of a dielectric material is inserted here. One side of said tube (64) is connected to the interior of waveguide (63), while the other side extends into through hole (62). Central coupling conductor (65) is inserted and secured in the central hole of said tube (64). One side of this conductor projects for a prescribed length into the interior of waveguide (63), and the other side is electrically and mechanically connected to output terminal (61).

The RF amplified output is transmitted from output terminal (61) to central conductor (65), and it is converted to the coaxial mode, with the outer conductor comprising through-hole (62), mounting plate (63') and the inner surface of the hole in the wall of the waveguide, for transmission in the coaxial line. The portion of central conductor (65) that projects into the waveguide radiates and pumps an RF wave inside the waveguide to form a waveguide mode that is transmitted toward the connecting flange (66) side. For each of the aforementioned plane circuit, coaxial line, and waveguide line, conversion is made for transmission in the corresponding transmission mode.

Because said conversion waveguide (63) is attached to the side of RF amplifier section (38), hole (67) that allows passage of flange (66) is formed in bottom (36) of the compartment of the main body. Waveguide bend (68) that is connected with a flange to said conversion waveguide (63) is arranged and attached inside main body (33), and this is connected to circular waveguide (58) by means of various types of waveguide elements (not shown in the figure) on the transmission side.

As shown in Figure 3, circular waveguide (58) is connected to a polarization branching filter (not shown in the figure) inside the main body, and it is connected to waveguide bend (68) from side A to side B through the aforementioned various types of waveguide elements on the

transmission side. Waveguide elements (69) are visible on the receiving side connected to the side surface of the aforementioned polarization branching filter.

The transmission signal is input from side B to transmitting part (32), and RF output for transmission is output at a low power level to side A. In this case, connection is made to RF amplifier section (38) by means of the aforementioned conversion waveguide, or by means of a connector coupling via the coaxial line alone. In RF amplifier section (38), because the RF wave is amplified to a high output power from side A to side B, it is converted for output in a waveguide by means of said conversion waveguide (63), and it is transmitted via the polarization branching filter through circular waveguide (58) to the antenna for emission.

Weak received RF waves incident on the antenna pass through the circular waveguide to the polarization branching filter, and are separated to pass into waveguide (69) on the receiving side. Coaxial conversion is performed at the end of waveguide (69) on the receiving side, and [the signal] is coaxially coupled and input to side A of receiving part (31). Electrical signal treatment is performed in receiving part (31), and the received signal is output on side B.

Effect of the invention

As explained above, for the device in this invention, the main parts of the receiving system and the transmission system are neatly accommodated in the main body. By simply opening the lid, it is possible to check and service these parts, and heat generated in the main body can be dissipated well by means of the compartment, lid, and heat dissipating fins on the side surface.

Because the RF amplifier section at the bottom of the main body is electrically separated and shielded, the reliability is high, and even the high amount of heat accompanying the high-power amplifier is dissipated well by means of the plural heat dissipating fins, of large area and independent from the main body.

The overall system is compact and has a completely waterproof and airtight structure. Consequently, it can be directly combined with the antenna, and the effect is significant in practical application.

Brief description of the figures

Figure 1 is a cross section illustrating the principle of the device in this invention. Figure 2 is an oblique view illustrating the state when the lid shown in Figure 1 is opened. Figure 3 is an oblique view illustrating the state when the lid is opened in an application example of the device of this invention. Figure 4 is a cross section of the view in Figure 3. Figures 5 and 6 are, respectively, an oblique view and cross section of the conversion connecting portion. Figure 7 is an oblique view illustrating a conventional device.

21 Main part of circuit
22, 33 Main body
24, 35 Lid
27, 38 RF amplifier section

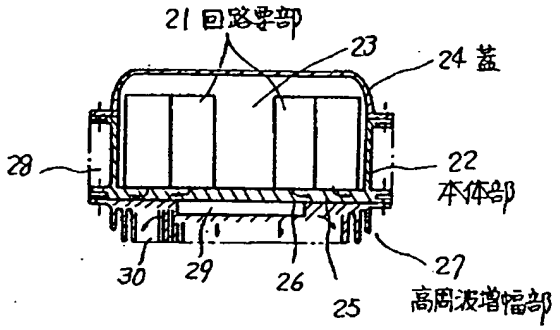

Figure 1. Cross section illustrating the principle of this invention

Key: 21 Main part of circuit
22 Main body
24 Lid
27 RF amplifier section

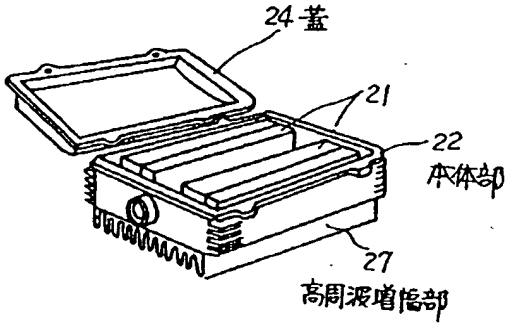

Figure 2. Oblique view of the device shown in Figure 1

Key: 22 Main body
24 Lid
27 RF amplifier section

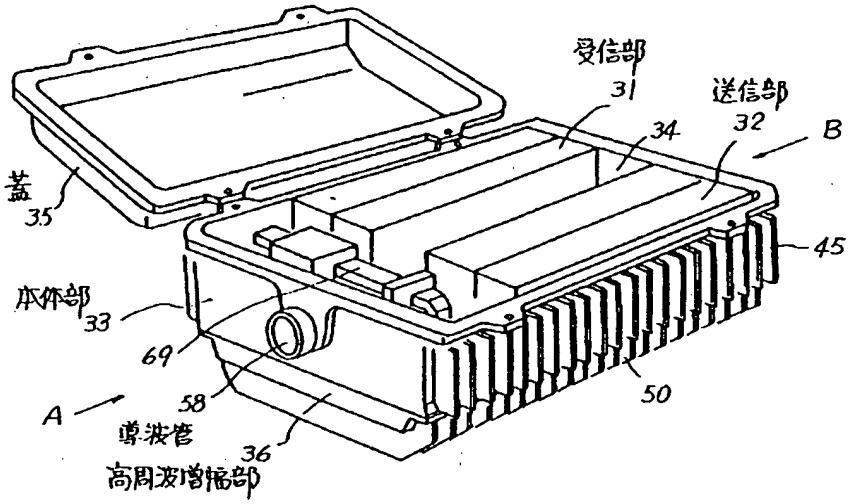

Figure 3. An application example of this invention

Key:
- 31 Receiving part
- 32 Transmitting part
- 33 Main body
- 35 Lid
- 36 RF amplifier section
- 58 Waveguide

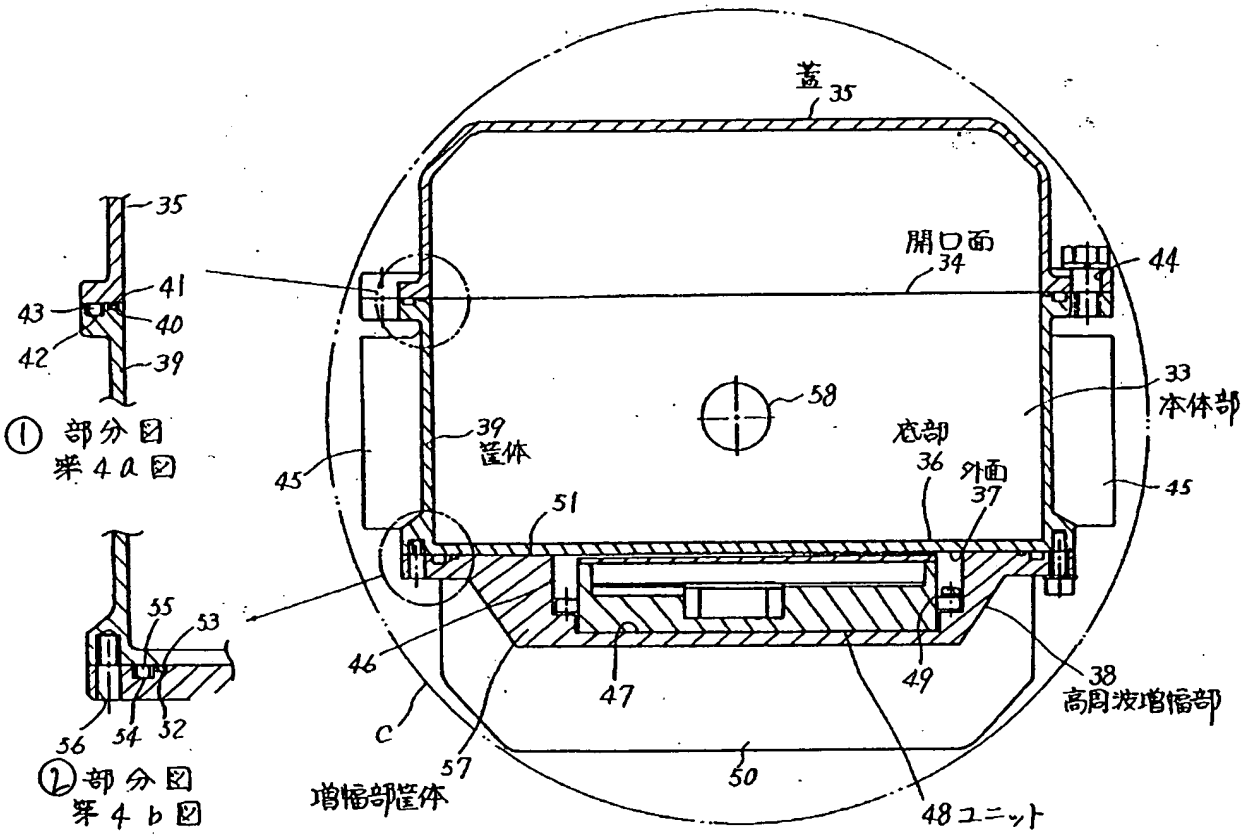

Figure 4. Cross section of Figure 3

Key:		
	1	Figure 4a. Partial
	2	Figure 4b. Partial
	33	Main body
	34	Opening
	35	Lid
	36	Bottom
	37	External surface
	38	RF amplifier section
	39	Compartment
	48	Unit
	57	Enclosure of amplifier section

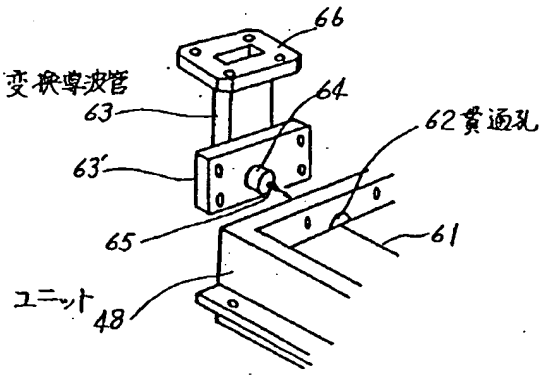

Figure 5

Key: 62 Through-hole
63 Conversion waveguide

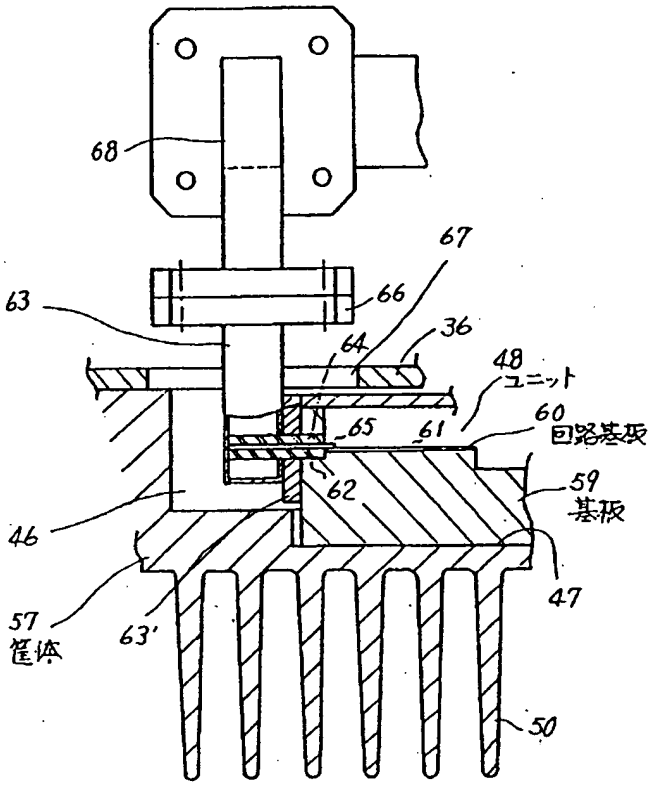

Figure 6

Key:
48 Unit
57 Enclosure
59 Base plate
60 Circuit substrate

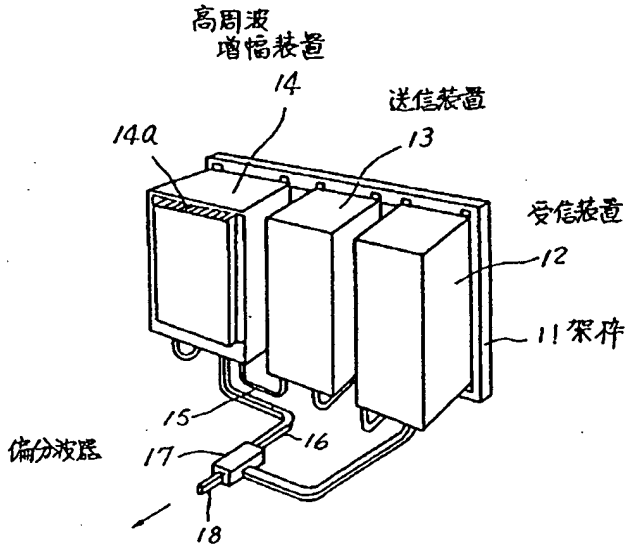

Figure 7. Conventional radio communication device

Key:
- 11 Frame
- 12 Receiver
- 13 Transmitter
- 14 RF amplifier device
- 17 Polarization branching filter